Presentation 11 – Susan Proctor

SPATIAL ANALYSIS OF 1991 GULF WAR TROOP LOCATIONS IN RELATIONSHIP WITH POSTWAR HEALTH SYMPTOM REPORTS USING GIS TECHNIQUES

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PRESENTATION OUTLINE

- Overview of GIS
- Application of GIS to study of GW veterans' health
- Research study
- Discussion
- Other research projects

OVERVIEW OF GIS

GIS= Geographic Information Systems

GIS technology is a database tool that enables the

- Input
- Storage
- Management
- Analysis
- Display

} of both geographic & non-geographic data into a database structure

GIS IN PUBLIC HEALTH

GIS, combined with temporal-spatial analysis methods,

-provide a methodology for understanding associations between location, environment, and disease.

Application Examples

- Hookworm infection/reinfection in S. Africa (Saathoff et al., 2005)
- Arsenic in drinking water in Bangladesh (Hassan et al., 2003)
- Herbicide exposures in Vietnam (Stellman et al, 2003)

KNOWLEDGE GAPS IN STUDY OF 1991 GULF WAR VETERANS' HEALTH CONCERNS

- Lack of baseline, pre-deployment health and lifestyle information to be able to examine influence on post-deployment health outcomes.
- Health outcomes often measured long after deployment.
- No uniform description of health outcomes consistent across GW veterans.
- Over-reliance on self-report measures of outcome and exposure variables.
- Lack of objective environmental exposure data to examine exposure-health effect relationships.

APPROACHES USED WITH SURROGATE EXPOSURE MEASURES

- ✓ Time period of deployment (Spencer et al., 1998)
- ✓ Reported movement into different regions (Steele et al., 2000)
- ✓ Unit-level troop locations coupled with modeled exposure estimates, to oil fire smoke (Lange et al., 2002) and Khamisiyah plume (McCauley et al., 2002; Smith et al., 2003)
- ✓ Spatial analyses of troop locations to examine patterns (this study)

RESEARCH OBJECTIVE

Examine whether the GW locations of soldiers who are categorized as having severe postwar chronic multisymptom illness display local and global spatial autocorrelation patterns.

Were troops, who later became ill, clustered in particular locations at the points of time of interest during their deployment?

→ If so, further investigation into unique exposure scenarios present at these locations at these timepoints can help frame hypotheses for further study.

DEVENS COHORT STUDY BACKGROUND

DEVENS Cohort: Prospective study of US Army Active, Reserve, and National Guard GW veterans.

Time 1: Survey, Spring 1991 (n = 2,949)
Time 2: Survey, Winter 1992/Spring 1993 (n = 2,313)
Time 3: In-person assessments, Fall 1994/ Summer 1996; Stratified, random sample of larger cohort (n=220)
Time 4: Survey, Fall 1997/Fall 1998 (n=1,291)

CHARACTERISTICS OF DEVENS COHORT AT TIME 1 (n=2,949)

	Mean (SD)/ Percent	Range
Age (years)	30.2 (8.4)	19-65
Education (years)	13.2 (1.8)	7-24
Gender (% female)	8.1	
Race:		
% white	82.8	
% black	8.7	
Service type:		
% Guard	51.6	
% Reserve	20.2	
% Active	28.2	

PUBLISHED REPORTS TO DATE FROM THE DEVENS COHORT STUDY

- Traumatic events/exposures and PTSD symptomatology
- Sexual harassment and PTSD symptomatology
- GW environmental exposures and health symptomatology
- GW environmental exposures and cognitive functioning
- Troop locations during the GW and health symptomatology
- Relationship of psychiatric status to GW veterans' health
- Rates of MCS, CFS, and CMI
- Health-related quality of life (SF36)
- Changes in PTSD over time

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ENVIRONMENTAL-GEOLOCATION INTERVIEW STRUCTURE

- **Deployment descriptive information: dates, units, & job types**
- **Deployment location information (with assessment of recall ability)**

GROUP DEMOGRAPHICS AND DEPLOYMENT CHARACTERISTICS

	Study Group (n=173)
Age	34.5 (9.4) [range: 22-61]
Education	13.9 (2.2) [range: 9-24]
% Female	47%
% Reserves/NG	89%
# weeks deployed	18.7 (6.2) [range: 5-36]
% moved > 3 times	82%
% unit moved together	65%
% went into Kuwait	39%
% went into Iraq	44%

DATE PERIODS EXAMINED	MARKER DEPLOYMENT EVENTS
#1 Second week in December 1990	Pre-combat phase
#2 Third week in January 1991	Air offensive begins; first Scud missile launched against US and allies
#3 Second week in February 1991	Oil wells were set on fire by retreating Iraqis in late January/early February, 1991
#4 Fourth week in February 1991	Allied ground war began 24 Feb 1991 and ended with the cease-fire 28 Feb 1991
#5 First week in March 1991	The demolition of munitions at Khamisiyah pit and demolition of bunker at Khamisiyah, Iraq
#6 Second week in April 1991	Post-combat phase

CHRONIC MULTISYMPTOM ILLNESS CASE CRITERIA

- **Two or more of the following three self-reported symptoms :**
  - **fatigue**
  - **mood-cognition (feeling depressed, difficulty remembering or concentrating, feeling moody, feeling anxious, trouble finding words, or difficulty sleeping)**
  - **musculoskeletal (joint pain, joint stiffness, or muscle pain)**
- **Chronic presence (six months or longer)**

CHRONIC MULTISYMPTOM ILLNESS CATEGORIZATION

CMI	Study Group (n=173)
None	31%
Mild-to-moderate	34%
Severe	35%

SPECIFIC RESEARCH QUESTIONS

Examining each time period separately:

Question #1: Are there significant clusters of cases (persons with post-war severe CMI) when looking globally over the entire geographical region?

Question #2: Are there significant pockets or clusters of cases at specific identified locations, when compared to neighboring areas?

RESEARCH QUESTION #1

Examining each time period separately:

Are there significant location clusters of cases (persons with post-war severe CMI) when looking globally over the entire geographical region?

USE: Global Moran's *I* statistic

Global Moran's *I* – Hypothesis

Global Moran's *I* Statistic to examine spatial patterns over region

H_0: The spatial distribution of the veterans, who postwar met criteria for severe CMI, is random.

H_1: The spatial distribution of the veterans, who postwar met criteria for severe CMI, is not random; there is a significant spatial pattern.

Global Moran's *I* – Results

	Group meeting severe postwar CMI criteria (maximum n=60)		Group not meeting severe postwar CMI criteria (maximum n = 113)		Overall Study Group (maximum n = 173)	
Date Period	*I*	Z(*I*)	*I*	Z(*I*)	*I*	Z(*I*)
2nd_Dec_90	**0.268**	**3.815 ***	-0.012	0.016	0.118	1.787
3rd_Jan_91	0.093	1.441	-0.073	-0.817	0.06	0.996
2nd_Feb_91	0.016	0.396	-0.06	-0.632	-0.016	-0.03
4th_Feb_91	-0.041	-0.381	0.046	0.805	-0.011	0.031
1st_March_91	0.1	1.537	-0.066	-0.711	-0.009	0.055
2nd_April_91	-0.024	-0.145	-0.09	-1.047	0.029	0.571

*** $p < 0.05$**

RESEARCH QUESTION #2

Examining each time period separately:

Question #2: Are there significant pockets or clusters of cases at identified locations, when compared to neighboring values?

USE: Local G* statistic
(compared to outside buffer area)

USE: Local Moran's *I* statistic
(compared to within buffer area)

LOCAL STATISTICS-HYPOTHESIS

Examination of spatial patterns of cases within location regions, determined by buffer area dimensions

H_0: The spatial distribution of the veterans meeting criteria for severe CMI is <u>random</u>, when comparing between neighboring locations and defined by buffer differences.

H_1: The spatial distribution of the veterans meeting criteria for severe CMI is <u>not random</u> and there is a significant spatial pattern/clustering, when comparing between neighboring locations and defined by buffer differences.

SUMMARY OF RESULTS FROM LOCAL STATISTICS

<u>Local G* statistics- significant local clusterings observed*</u>

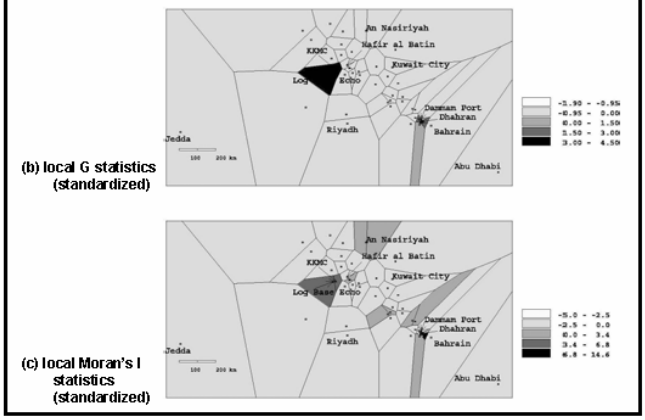
Dhahran/Dammam area	→	second week Dec 1990
	→	third week Jan 1991
KKMC/Log Base Echo area	→	third week Jan 1991
	→	second week Feb 1991
An Nasiriyah area of Iraq	→	first week March 1991

<u>Local Moran's I statistics- significant local clusterings observed *</u>

Dhahran/Dammam area	→	second week Dec 1990
	→	third week Jan 1991
KKMC/Log Base Echo area	→	third week Jan 1991

* Bonferroni correction applied

CMI Rates: 3rd week in January,1991



Flow of Troop Locations Over Time

Question- Are the hotspots simply artifacts of troop deployment patterns, as they appear to follow general flow of troops during the 1991 Gulf War?

Additional analyses to examine whether hotspots could be explained primarily by troop flow

1. Examined whether the same persons were included in the significant location clusters over time.
   Result: Clusters did not always contain the same individuals across time
2. G statistics calculated for group not meeting criteria for severe CMI and examined spatial pattern over same date periods
   Result: Two previously identified significant hotspots (Dhahran/Dammam area in 2nd week in Dec 1990 & KKMC/Log Base Echo area in 2nd week in Feb 1991) were present both for veterans reporting severe CMI and those who did not meet the criteria for severe CMI

SUMMARY OF RESULTS FROM LOCAL STATISTICS-CONCLUSIONS**

Significant local clusterings observed

Dhahran/Dammam area ⟶ third week Jan 1991

KKMC/Log Base Echo area ⟶ third week Jan 1991

** After taking into consideration Bonferroni correction for multiple comparisons, flow pattern of troop movements, and results from both local G* and Moran's *I* statistics.

DISCUSSION ITEMS

- ✓Use of interview data (rationale)
- ✓Comparison of severe cases vs. others (rationale)
- ✓Bonferroni factor-multiple comparison adjustments
- ✓Issues of flow of troop movements
- ✓GIS limitations & integration with statistics

POTENTIAL NEXT STEPS

- ❑ Confirm findings with larger and diverse cohort.
- ❑ Apply methodology to examine other health outcomes.
- ❑ Explore the potential applicability of complex spatio-temporal GIS and statistical techniques to research questions.
- ❑ Identify exposure-effect hypotheses to target in further epidemiologic research.
- ❑ Identify lessons learned from the research challenges in investigations of 1991 GW veterans' health to improve future force health protection.

CURRENT ONGOING
RESEARCH